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SEMICONDUCTOR TECHNOLOGY FLOWS THROUGH FORMAL TECHNOLOGY TRANSFERS

Abbie J. Griffin
Sloan School of Management
Massachusetts Institute of Technology

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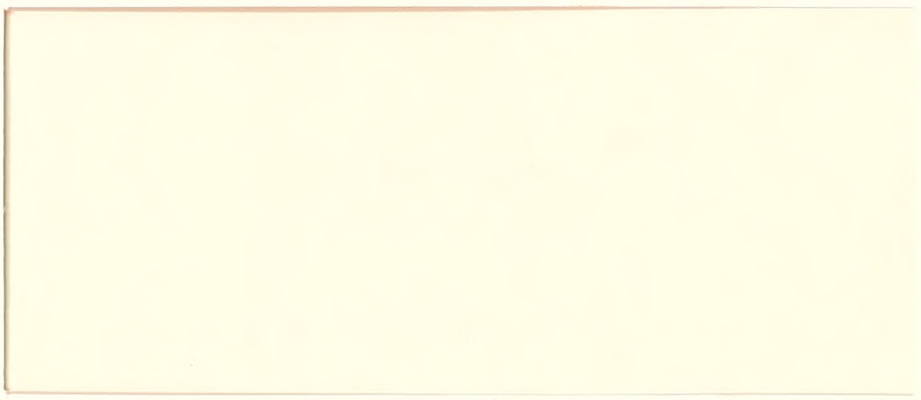

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ABSTRACT

This analysis was done to identify how much semiconductor technology flows internationally through formal technology transfer mechanisms, via which mechanisms, and in which direction. The formal mechanisms investigated for transferring technology include: interfirm licensing, cross-licensing and second source agreements, firm mergers and acquisitions and direct investment in firm-owned foreign facilities.

In general large American companies have allowed their technology advantages to be diffused both to smaller, startup competitors in the US and to foreign competitors in 3 competitive geographies: Japan, Europe and Korea.

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PURPOSE:

This analysis was done to identify how much semiconductor technology flows internationally through formal technology transfer mechanisms, via which mechanisms, and in which direction. The formal mechanisms investigated for transferring technology include: interfirm licensing, cross-licensing and second source agreements, firm mergers and acquisitions and direct investment in firm-owned foreign facilities.

MAJOR CONCLUSIONS:

The analysis indicates that the US semiconductor industry suffers a net outflow of technology through formal technology transfer mechanisms, while Europe, Japan and Korea all maintain net technology inflows through their formal technology transfer policies. The Japanese consistently use more mechanisms, more frequently, directed at specifically obtaining semiconductor technology from international sources than does the US. The US is the focus of Japan's technology acquisition effort. The US is also the focus of European and Korean technology acquirers. However, there are some significant differences in the way the Europeans and Japanese approach acquiring semiconductor technology from the US. While both heavily use interfirm agreements such as technology exchanges, second source agreements and licenses, the Japanese also invest in numerous facilities located in the foreign country as a technology acquisition mechanism. Europeans, on the other hand, frequently acquire US technology by acquiring all or part of US companies or divisions of companies.

While US firms are in general noted for their bent toward mergers and

acquisitions, semiconductor firms have not centered merger activities around acquiring foreign firms. Americans have also not been as active in foreign facility investment; foreign facilities installed tend to be for cost advantage purposes, not for placement in strategic locations which may provide the firm with new technology or insight into foreign markets.

Intra-European interfirm agreements tend to be between larger players where each may be able to gain. US-US interfirm agreements tend to diffuse technology from the major players to smaller (and presumably less technically able) corporations. In general, larger American firms have forged agreements which raised the overall level of technical expertise of small companies, from whom it is unlikely they could obtain comparable technological gains in return. For example, of the 9 US second source suppliers of 16 bit microprocessors, none was one of the other 5 original 16 bit microprocessor suppliers. European and Japanese firms can in turn acquire technology originally sourced from the major American firms indirectly through the smaller firms they made agreements with. These small firms are more likely to need cash and be more willing to sell or license technology to foreign companies in return for cash (no cross-technology exchange) than would the major firms.

In general, then, large American semiconductor companies have allowed technology advantages to diffuse both to smaller, startup competitors in the US and to foreign competitors in 3 geographies: Japan, Europe and Korea.

SOURCE OF DATA:

The data for this analysis come from 2 sources: "Technical Alliances in the Semiconductor Industry" (Carmela S. Haklisch and Pierre Pouletty, New York University Graduate School of Business Administration, Center for

Science and Technology Policy, February, 1986); and "Technology Networks Between US and Japanese Industry" (Lois S. Peters, Center for Science and Technology Policy, School of Management, RPI, March, 1987). Using citations from business and technical literature, a survey of firms, and interviews, data were gathered on almost 250 agreements, investments, and mergers forged between 1978 and the end of 1984. The research emphasized data gathering and reporting, with minimal analysis. This paper presents conclusions based on additional analyses of the data gathered by these two groups.

Reports on the findings were published primarily for each Center's Corporate Membership and three other organizations sponsoring the work: the National Science Foundation, North American Philips Corporation, and IBM. While these reports are available from the authors, their findings have not yet been published elsewhere in the literature.

ANALYSIS:

The studies gathered data on 3 possible mechanisms which could broaden the base of science and technology and resorces available to a corporation; acquisitions and equity investments, facility investments in other countries, and international interfirm agreements, including joint ventures, technical exchanges, licensing and second source agreements. The groups also identified and recorded 34 US-US interfirm agreements forged between 1981 and 1984. The flow of technology is first analyzed through each mechanism separately, then all the international mechanisms are combined to compile an overall list of technology acqisition "winners" and technology dissipation "losers."

US-US Interfirm Agreements and Technology Flow

The reports identified 34 agreements between 28 US companies, covering 54 product area agreements forged between 1981 and the end of 1984. From the few years of data, it is not clear whether the number of interfirm technology transfer agreements is stable or increasing slightly over time:

Year	1981	1982	1983	1984	Total
Number of Agreements	9	8	5	12	34

Average #/year = 8.5

From descriptions, the interfirm agreements can be categorized as exchanges of compatible technologies, codevelopment agreements and technology cross-licenses, or second source agreements and technology licenses. Figure 1, a map of US-US links by agreement category, shows that a cluster of 5 companies accounts for the bulk of the interfirm links. Intel, National Semiconductor, Texas Instruments (TI), Advanced Micro Devices (AMD), and Motorola participate in 42 (78%) of all US-US links. Of the 23 other companies in this network, only 4 have no technology links to one of these major companies (AMI, Linear Technology, MA-Com, and VLSI). The remaining 19 all have links to one or more of these major licensing companies. This suggests that US-US technology links may be diffusing technology away from the major semiconductor manufacturers to their smaller counterparts.

Table 1 presents additional data which supports this assertion. Links between the 5 major manufacturers account for 20% to 40% of each firm's total technology links. Inter-major links account for only 28.6% of the 5-firm total number of links; the other 71.4% are links between major and minor firms. Links between smaller US companies and the majors account for 48.5% of the total number of links the smaller companies participate in. They are active participants both with the majors and with each other.

These two analyses suggest only that the large firms have numerous agreements, mostly with smaller manufacturers. They do not indicate which way technology flows in the network. The larger firms may be tapping the smaller ones for their unique technology. The purpose of the third analysis is to try to determine the net flow of technology in the network, sum up inflows and outflows and obtain rough, relative measures of technology winners and losers within the US network.

The information in each agreement was studied to categorize what actually was transferred from which technology source firm to which receiving firm. Each type of exchange was assigned a numerical value from -2 to +2, depending on whether the firm was a technology reciever (a positive value) or source (a negative value). The specific numbers assigned to each transfer type correspond to one estimation of the relative competitive loss or gain each transfer type might have associated with it. In doing this analysis, the links were counted, not revenues or technology "value." Please note that it is not the actual numbers which are relevant, but the comparative magnitudes. The coding scheme was:

	Reciever	Transmitter
Second Source	+2	-2
Technology License	+2	-2
Technology Exchange	+1	-0.5
Co-development	+1	-0.5
Cross-License	+1	-1

Second source and technology licensing agreements (for money) are straight technology losses. While a firm may gain revenue through second source or license agreements, it loses most or all competitive advantage for

the product or technology. Ten of the 54 total links (18.5%) were second source agreements. The licensing company must give the licensor enough technical input so that they can manufacture a good product. In return, the licensor obtains money for units sold by the licensor, as well as increased competition from them in the marketplace.

When firms exchange technology, they show each other pieces of their technology or process, but do not permit direct use of that technology in products. Co-developments are joint research agreements. The cost to develop a technology (product) is halved for each firm, assuming only 2 firms participate. For a technology exchange or co-development, a company probably loses some of their technological competitive edge, but they may also gain some from another firm. Overall, the firms who exchange or co-develop technology will probably come out a little above even.

In straight cross-licensing agreements, if one assumes that firms are soemwhat rational, then they will cross-license approximately equal "amounts" of technology. Thus, a cross-license probably neither helps nor hinders a receiver or source, in the net, since each firm is both a source and a receiver for any given agreement.

Table 2 shows the relative scores calculated for each US firm from their US-US technology transfer agreements, using the receiver/source coding scheme presented above. Table 3 presents the same firms ranked into relative "winners" and "losers." From this analysis Intel, LSI, Motorola and National Semiconductor have diffused away the most technology. The biggest technology acquirers are AMD, who seems to be a second source favorite, General Instruments and Mostek.

Second source agreements deserve some special comments since they directly provide companies with competitive product information. Table 4

lists the total number of producers and numbers of US and Japanese vendors for the 5 major 16 bit microprocessors (MPU's). Of the 26 product vendors, US firms account for over 50% of the total, the Japanese account for 19.2%, and Europeans for 26.9%. Three of the 5 Japanese firms are unlicensed, but all others are licensed by the companies to produce these products.

The companies have taken very different second source strategies as far as the numbers and nationalities of their licensees. National Semiconductor and TI second source only to US companies. TI only licensed one other company to produce its MPU; National licensed 2 others. Intel, on the other hand, has 1 Japanese MPU licensee, 2 European firms, and 2 other US vendors, as well as 3 other non-licensed Japanese vendors. Motorola has licensed 3 Europeans and 1 Japanese company as second sources.

Of all the vendors, only AMD and Siemens produce 2 MPU's - they each produce both the Intel 8086 and Zilog Z8000. No other vendor (including the Japanese producers, both licensed and unlicensed) produces more than one 16 bit MPU. More importantly, no licensor made second source agreements with any firm who had already developed and produced their own 16 bit MPU. All agreements are with firms with no access to their own MPU design.

This second source behavior on the part of US companies is curious. If you licensed your MPU to another firm which already sold their own design, that firm would produce both, but probably more actively market only their design. By licensing only to firms who had <u>not</u> already developed their own 16 bit MPU, the licensing firms set up very active direct compeititors for their own products.

The second question about the appropriateness of this behavior arises if companies view customer relationships in the long term. Why, if you care about the quality of product your customers get, license a second source who

is not every bit as good at MPU production as you are? If a firm licenses the rights to build a product to a company who they know can build their own similar product with reasonable quality, then 1) other than the design (which any second source is going to have to learn anyway) the licensing firm will not gain much new technology from your company and 2) your customers will have product available from 2 capable sources, not one capable (your firm) and one more questionable source.

What the Americans seem to have done with their American licensing is to license their MPU technology to firms smaller, less capable in MPU design than they are. The logic may have been, "They can never be as good as we are, therefore they are 'safe' to license, even though they are American competitors." Second sourcing only other large US firms could potentially have acted to isolate newcomers from current production and/or product technology and helped keep the industry concentrated in the hands of the 5 major semiconductor producers.

What appears to actually have happened is that the large American firms have helped grow new US and foreign competitors by giving them enough of their technology base so that they can catch up far faster than they could have without the technology help. Second source agreements, technology licenses, and other transfer links have all worked together to dissipate technology away from most of the larger American firms and into the hands of newer and second tier firms.

International Acquisitions and Equity Investments

As shown in Table 5, over 90% of the recorded international acquisitions or equity investments between 1978 and 1985 have been aimed at US companies. Only two other international investments have taken place; both in Korean

companies. Of the investments in US firms, 79% were made by European companies; the remaining 21% were made by Japanese companies. Clearly, acquisitions and equity investments seem to be a major means of technology acquisition for the Europeans.

In general, the nature of the acquired companies differs, as well. Twenty % of the European investments or acquisitions were relatively large, usually second or third tier, producers or divisions of other companies. AMD, Signetics and Fairchild are the large companies acquired. Other than an equity position in Amdahl, the Japanese companies have tended to acquire only start-ups or much less well-know divisions of larger conglomerates.

Foreign Facility Investment

While Japan does not tend to acquire or invest in US companies to the extent that the Europeans do, they invest heavily in Japanese-owned facilities located in foreign countries, as Table 6 shows. The Japanese own 52.5% of the 40 recorded facilities built in foreign countries between 1978 and 1985. Two-thirds (14 out of 21) of those facilities have been built in the US, all but one of the remainder are in Europe.

The Europeans, on the other hand, have built only 15.0% (6) of the foreign facilities. The Japanese seem to prefer to "grow their own" interface with the foreign country, while Europeans are content to try to adapt what is already available for their own purposes. Whether these strategies arise due to matters of cultural or management style mismatch can only be surmised.

Even more interesting is the data on foreign-owned design centers, shown in Table 7 (this is a subset of Table 6). Over half of the facilities built by Japan are design centers -facilities that keep contact with the needs of

customers in that particular country and transmit those needs back to the production plants, where ever they are located. The connections are usually made nearly instantaneously through satellite links in the 2 countries. Almost 82% of the Japanese design centers (9 out of 11) are built in the US. These facilities potentially position them to move from mass-production dominated product lines, like memory chips, into the feature-driven product lines (CPU's, MPU's and special order design) where US firms have traditionally been strong.

US firms have 9 foreign facilities (22.5% of the 40 total foreign facilities) spread throughout the world, with over half of them in Japan. However, only 33.3% of these facilities are design centers, compared with over 52% of the Japanese foreign facilities. The rest of the US facilities are primarily production facilities located off-shore for cost advantages.

A total of 57.1% of the facilities built in the US by all foreign firms are design centers; everyone is trying to speed their knowledge of what products US users want. However, only 37.5% of the foreign facilities built in Japan are design centers. While the Japanese are learning how to invade US markets through their design centers, continuing to build export volume that way, we Americans, and the Europeans are not learning how to invade their markets in retaliation. We are using foreign facilities as production (and more slowly, as research) centers, not as bases for directing global product marketing. The Japanese are using their numerous facilities as much for bases for global product marketing as for production and technology development sites.

International Interfirm Agreements and Technology Flow

Between the 2 studies, 114 international agreements were identified in

which 75 companies transferred technology between eight countries on 4 continents (see Table 8). Over half of the companies involved in the agreements were located in the US (56.0% of 75 companies, or 42). American firms participated in 86.0% of the agreements, with each US company participating in 2.3 agreements, on the average.

Compared with the US figures, the Japanese numbers are very concentrated. Only 13 Japanese companies (17.3% of the total) were involved in the international agreements, but they participated in 54.4% of the agreements. Each Japanese company participated in 4.8 agreements, on average, more than twice the number each US company participated in.

Korea's 4 countries follow behavior patterns very similar to the Japanese - they each participate in about 4.8 agreements. European companies are somewhere in the middle; not as fragmented in their agreements behavior as US companies, but also not as concentrated at the Japanese or Koreans. The 16 European companies participate in 3.1 agreements, on average.

The US is the major trading partner for companies located in all non-US countries (Table 9). After the US, the Europeans make more intra-continent agreements than with any other partner, while the Koreans trade with Japan more than anyone else. The European and Korean preference for European and Japanese technology trading partners (after the Americans) may be partially explained by geographic proximity. However, proximity does not account for the primary emphasis on US partners for technology agreements.

As with the analysis done earlier of US-US technology flows, just analyzing numbers of agreements does not give a sense of where technology is flowing from and where it is going to. To get an idea of the flow of technology, each agreement was coded by type(s) of technology transfer. Corporate, national and continental gainers and losers of technical

competitive advantage were determined using the same procedures and coding schemes used previously in the US-US interfirm agreement analysis.

Table 10 presents the results of the continental technology transfer analysis. Column 1 of the table suggests that the United States has in fact dissipated its technology through interfirm agreements to Europe, Japan, and even Korea, through the agreements signed over the last 10 years. The second and third columns in the table add relative changes of technology advantage due to foreign acquisitions and equity investments, and investments in constructing foreign facilities, respectively.

That Japan does not appear to be the largest technology "gainer" may seem surprising at first, since it is the Japanese who have given the Americans so much competitive trouble in semiconductors. This is an artifact of the way the data in Table 10 are presented (by continent). When the analysis is done by individual country, Japan does come out the largest individual country technology gainer. The next largest acquirer of technology is Korea, followed by France and Germany.

Table 11 shows how various US companies contributed to semiconductor technology outflow. From the data available and the way the analysis was performed, one can conclude that Fairchild, Intel, Motorola, and Zilog provided the whole US deficit, although that conclusion might be a bit unfair. Technology flows for all remaining US companies just about balance, with some "gaining" technology and others "losing" a bit of it.

Table 12 shows how each foreign company contributes to its country's acquisition of semiconductor technology. Over half of Europe's gains are due to Thomson CSF of France, Siemans of Germany, and NV Philips of the Netherlands. Most technology acquisition in Japan is concentrated in 4 companies: Fujitsu, Matsushita, NEC, and Toshiba. Over two-thirds of Korea's

technology acquisition has been driven by Gold Star and Samsung.

Summary

Nine foreign companies seem to be the major benefactors of US developments in semiconductor technology. They have used several formal technology transfer mechanisms, as well as direct investments in foreign firms and building research, development and design centers on foreign soil to acquire this technology.

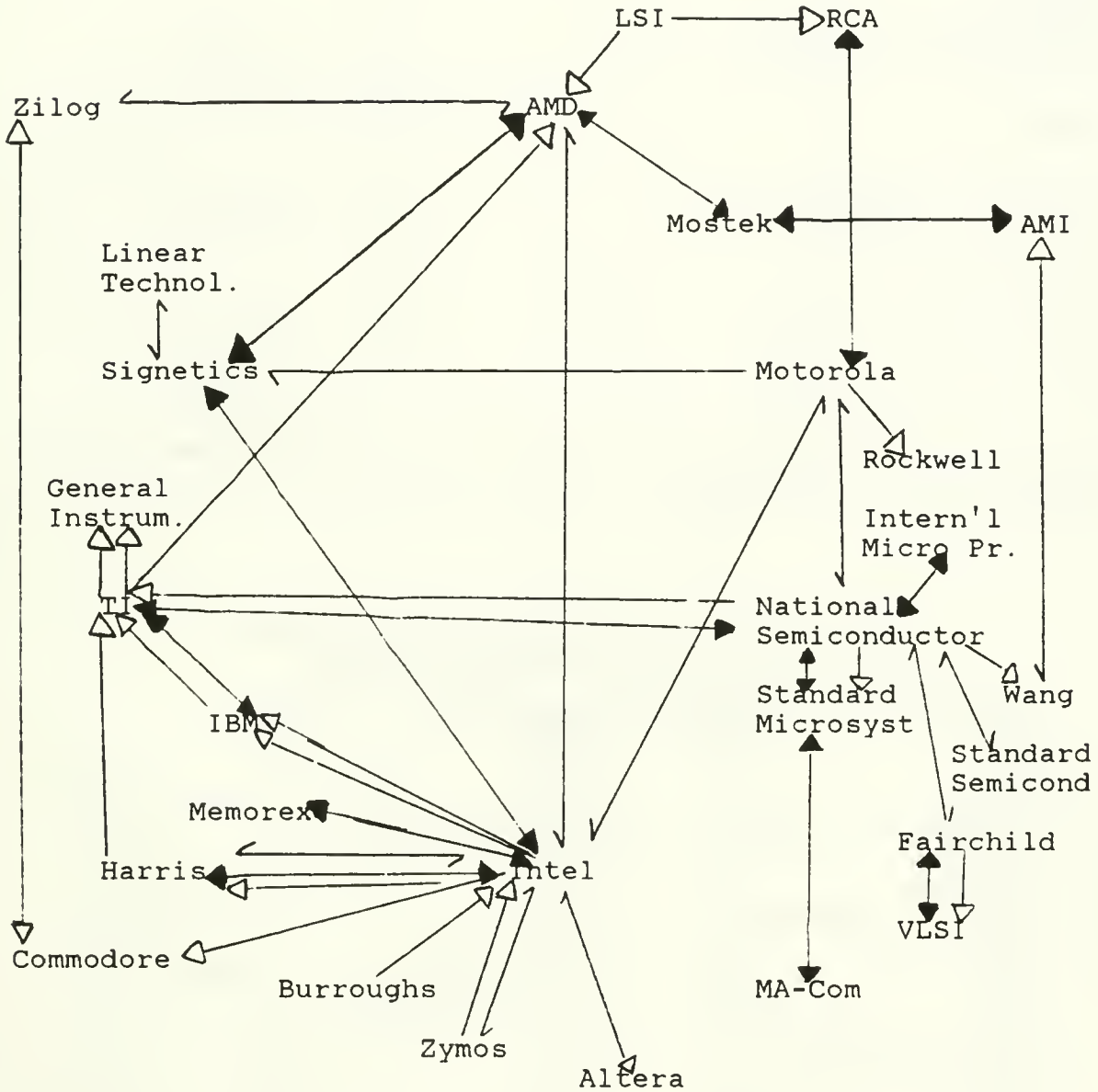
To date, US firms have not individually or collectively refrained from licensing technology or entering into agreements with foreign firms. The temptation to "make a fast buck" out of "outdated technology" has worked to continually erode the technical competitive advantage of many US companies. Many of those foreign companies that the US licensed have developed strong mass-production capabilities, allowing them to acquire US market share in products originally developed by US companies. Their strong production capabilities have in turn given them competitive advantages in other markets that US producers did not intend they get into.

Should some of the larger US companies try to stop the formal transfer of technology overseas, they may be thwarted because of the propensity for large US companies to second source and diffuse technology to smaller US companies, who in turn run into cash flow problems and turn to quick cash deals with foreign sources. Stopping this source of US technology may require large US companies to either 1) collectively become responsible for the economic wlefare of all US start-up semiconductor companies or 2) continally work to consolidate the semiconductor industry by rapidly acquiring new start-ups as or shortly after they appear. Either of these strategies may be very expensive, but the potential cost must be weighed

against the potential cost of lost competitive advantage if nothing is done to stem formal technology transfer of semiconductor technology overseas.

US companies now worry about the leakage of semiconductor technology overseas through informal or uncontrollable mechanisms; researchers speaking international conferences, journal articles, and casual conversations between researchers. The evidence from this analysis suggests that the amount of international technology transfer that has taken place with the full backing and consent of US companies should be a far more enormous worry than what may take place more informally.

Figure 1. REPORTED US-US TECHNOLOGY EXCHANGES, CROSS-LICENSES, SECOND SOURCE AND JOINT VENTURE AGREEMENTS 1980-1984



Second Source Agreement
Codevelopment Agreement, Technology Exchange
Cross License

Table 1. DISPERSION OF US-US TECHNOLOGY AGREEMENTS

Company Major Firms	Total Technology Transfers	# of Transfers Between Major Firms	% of Total Transfers	Number of Major Firms Linked to
Intel	15	3	20.0%	2
National Semiconductor	9	3	33.3%	2
Texas Instruments	8	2	25.0%	2
AMD	6	2	33.3%	1
Motorola	5	2	40.0%	1
Total of Majors	43	12	27.9%	
18 Remaining Firms	65	32	49.2%	
Total of all Firms	108*	44	40.7%	

* This figure is more than twice the number of actual agreements because for each one there are 2 companies, a transmitter and a source, and perhaps multiple transfers per agreement.

Table 2. RELATIVE TECHNOLOGY GAINS AND LOSSES FOR US-US TECHNOLOGY TRANSFER AGREEMENTS

Company	Score	Company	Score
Altera	+2	Memorex	+0.5
AMD	+5	Mostek	+3
AMI	+2.5	Motorola	-5.5
Burroughs	-2	National Semi	-6
Commodore	+2	RCA	-1.5
Fairchild	-1.5	Rockwell	-2
General Instrument	+4	Signetics	+2
Harris	+0.5	Standard Micro	-1
IBM	+2.5	Standard Semi	0
IMP	+0.5	Texas Instruments	+1
Intel	-6	VLSI	+2.5
Linear Technology	0	Wang	0
LSI	-4	Zilog	0
MA-Com	+0.5	Zymos	-2

Coding Scheme:	Receiver	Source
Second Source	+2	-2
Technology License	+2	-2
Technology Exchange	+1	-0.5
Co-development	+1	-0.5
Cross-License	+1	-1

Table 3. DISSIPATION AND ACQUISTION OF TECHNOLOGY THROUGH US-US TECHNOLOGY LINKS

Dissipators of Large Amounts of Technology (-4 to -6)	Acquirers of Large Amounts of Technology (+3 to +5)
Intel	AMD
LSI	General Instruments
Motorola	Mostek
National Semiconductor	

Net Technology Losers (-1 to -2)	Net Technology Acquirers (+1 to +2.5)
Burroughs	Altera
Fairchild	AMI
RCA	Commodore
Rockwell	IBM
Standard Micro	Signetics
Zymos	Texas Instruments
	VLSI

Table 4. VENDORS AND SECOND SOURCE SUPPLIERS FOR 16 BIT MICROPROCESSORS

Microprocessor	Total Vendors	Number of US Vendors	US % of Total	Number of Japanese Vendors
Intel 8086	9	3	33.3%	4*
Motorola 68000	7	4	57.1%	1
Zilog Z8000	5	2	40.0%	0
National Semi 16000	3	3	100.0%	0
Texas Inst. 9900	2	2	100.0%	0
TOTAL	26	14	53.8%	5

* Three of these are unlicensed suppliers.

Table 5. INTERNATIONAL ACQUISITIONS AND EQUITY INVESTMENTS
1978-1985

		Country of Investee					
		US	Europe	Japan	Korea	Total	% of Total
Country of Investing Firm	US	X	0	0	1	1	4.8%
	Europe	15	X	0	0	15	71.4%
	Japan	4	0	X	1	5	23.8%
	Total	19	0	0	2	21	
	% of Total	90.5%	0%	0%	9.5%		100.0%

Table 6. INTERNATIONAL FACILITY INVESTMENTS
1978-1985

		Country of Investee					
		US	Europe	Japan	Rest of World	Total	% of Total
Country of Investing Firm	US	X	2	5	2	9	22.5%
	Europe	3	X	3	0	6	15.0%
	Japan	14	6	X	1	21	52.5%
	Korea	4	0	0	0	4	10.0%
	Total	21	8	8	3	40	
% of Total		52.5%	20.0%	20.0%	7.5%		100.0%

Table 7. INTERNATIONAL DESIGN CENTER INVESTMENTS
1978-1985

		Country of Investee					
		US	Europe	Japan	Rest of World	Total	% of Facilities*
Country of Investing Firm	US	X	0	2	1	3	33.3%
	Europe	1	X	1	0	2	33.3%
	Japan	9	1	X	1	11	52.4%
	Korea	2	0	0	0	2	50.0%
	Total	12	1	3	2	18	
% of Total* Facilities		57.1%	12.8%	37.5%	66.7%		45.0%

* These %'s are percents of the marginals and total facilities from Table 6

Table 8. INTERNATIONAL INTERFIRM AGREEMENTS BY COUNTRY
1978-1985

Country	# of Companies	% of Total	# of Agreements	% of Total	Agreements per Company
US	42	56.0%	98	86.0%	2.3
Japan	13	17.3%	62	54.4%	4.8
Europe*	16	21.3%	49	43.0%	3.1
Korea	4	5.3%	19	16.7%	4.8
Total	75	99.9%	114	200.1%@	3.0

* Includes Germany, France, Italy, the Netherlands, and the UK
@ Adds to 200% because there are 2 partners per agreement

Table 9. PROJECTS BY PARTNERSHIP
1978-1985

Partners	Number of Projects	% of Total
Japan - US	54	47.4%
Europe - US	30	26.3%
Korea - US	14	12.3%
Europe - Europe	6	5.3%
Europe - Japan	5	4.4%
Korea - Japan	3	2.6%
Korea - Europe	2	1.8%
Total	114	100.1%

Table 10. SUMMARY OF TECHNOLOGY BALANCE BY CONTINENT
Calculated from Technology Transfer Flow Analysis

Continent	Interfirm Agreement Score	Add in Acquisition Value *	Add in Foreign Facility Value @
UNITED STATES	-48.5	-52.9	-42.9
EUROPE	+53.0	+79.4	+84.9
JAPAN	+35.5	+46.3	+63.8
KOREA	+37.0	+36.0	+39.0

* Change in value = to the proportion they acquired of another company (positive) or another company acquired of them (negative).
@ Add one point for each foreign facility built.

Table 11. RELATIVE TECHNOLOGY GAINS AND LOSSES FOR INTERNATIONAL TECHNOLOGY TRANSFER AGREEMENTS WITH US COMPANIES

Company	Interfirm Agreement Score	Add in Acquisition Value *	Add in Foreign Facility Value @
AMD	-2	-2.4	-2.4
Amdahl	-2	-2.9	-2.9
AMI	+3.5	+3.5	+3.5
AT&T	+1	+1.9	+1.9
Burroughs	NA	NA	NA
Citel	+2	+2	+2
Commodore	NA	NA	NA
CS	+0.5	+0.5	+0.5
Custom MOS	+1	+1	+1
Fairchild	-4.5	-6.5	-6.5
GCA	+1.5	+1.5	+1.5
General Instrument	-2	-2	-2
GTE	+1	+1	+1
Harris	-2	-2	-2
Hewlett-Packard	0	0	0
H-K Semiconductor	+1	+1	+1
IBM	+1.5	+1.5	+1.5
IMP	NA	NA	NA
Intel	-18.5	-18.5	-17.5
IXYS	+1.5	+1.5	+1.5
Linear Technology	-2	-2	-2
LSI	-4	-4	-4
Micro Engineering	+1	+1	+1
Mitel	-2	-2	-2
Monomemory	+2	+2	+2
Mostek	+2	+2	+4
Motorola	-11	-11	-8
National Semi	-3.5	-3.5	-0.5
Panatek	+1.5	+1.5	+1.5
RCA	-0.5	-0.5	-0.5
Rockwell	+2	+2	+2
Signetics	+5	+3	+3
Sperry	-0.5	-0.5	-0.5
Standard AE	+1	+1	+1
Standard Micro	-1	-1	-1
Tektronix	-1.5	-1.5	-1.5
Texas Instruments	-5.5	-5.5	-4.5
Trilogy	-2	-2	-2
VLSI	0	0	0
WSI	-2	-2	-2
Zilog	-11	-11	-11
Total	-48.5	-52.9	-42.9

NA Not Available
* Change in value = to the proportion they acquired of another company (positive) or another company acquired of them (negative).
@ Add one point for each foreign facility built.

Table 12. RELATIVE TECHNOLOGY GAINS AND LOSSES FOR NON-US COUNTRIES

Company	Interfirm Agreement Score	Add in Acquisition Value *	Add in Foreign Facility Value @
EUROPE			
France			
Bull	+2	+2	+2
Matra	+1.5	+1.5	+1.5
Matra-Harris	+2	+2	+2
Schlumberger	0	+6	+7
Thomson CSF	+14.5	+16.5	+17.5
Total France	+20	+28	+30
Germany			
AEG Telefunken	+2	+2	+2
Nixdorf	+0.5	+0.5	+0.5
Siemans	+8.5	+18.9	+19.9
Voest-Alpine	+1	+1	+1
Total Germany	+12	+22.4	+23.4
Great Britain			
Ferranti	+2	+4	+4
GEC	+3	+5	+5
ICL	+3	+3	+3
Inmos	-4	-4	-4
Total Britain	+4	+8	+8
Italy			
Olivetti	+5	+5	+5
SGS-Ates	+5	+5	+7
Total Italy	+10	+10	+12
Netherlands			
NV Philips	+7	+11	+11.5
Total Netherlands	+7	+11	+11.5
TOTAL EUROPE	+53	+79.4	+84.9

Table 12. Continued

Company	Interfirm Agreement Score	Add in Acquisition Value *	Add in Foreign Facility Value @
JAPAN			
Asahi Chemical	+2	+2	+2
Fujitsu	+4	+4.8	+15.8
Hitachi	+1	+3	+3
Matsushita	+1	+1	+1.5
Mitsubishi	+6.5	+8.5	+9.5
NEC	+4	+6	+13
Oki	+3	+3	+3
Ricoh	+4	+4	+4
Sanyo	+4	+4	+4
Sharp	+1	+1	+1
Tandy	-2	-2	-2
Toko	+1	+1	+1
Toshiba	+6	+8	+8
TOTAL JAPAN	+35.5	+46.3	+63.8
KOREA			
Daewoo	+1	+1	+1
Gold Star	+14	+13.1	+14.1
Hyundai	+4	+4	+5
Korea Electronic	+4	+3.9	+3.9
Samsung	+14	+14	+15
TOTAL KOREA	+37	+36	+39

* Change in value = to the proportion they acquired of another company (positive) or another company acquired of them (negative).

@ Add one point for each foreign facility built.

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